

# The Biology of *Sclerogibba longiceps* Richards and *Sclerogibba embiidarum* (Kieff.) (Sclerogibbidae: Hymenoptera) parasitic on Embioptera.

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(With one plate)

## INTRODUCTION

Our knowledge of the hymenopterous parasites of Embioptera is restricted to the works of Richards (1939), Dodd (1939), and Callan (1939, 1952) who have recorded Scelionids and Sclerogibbids parasitizing the eggs and larvae respectively of some Embioptera. The discovery of *Sclerogibba embiidarum* parasitic on the larvae of *Oligotoma minuscula* Enderlein, *Sclerogibba longiceps* Richards on *Parembia* sp., and an unknown species of *Sclerogibba* on *Pseudembia flava* Ross has enhanced considerably the importance of this group. Table I lists the total number of hymenopterous parasites of Embioptera so far known.

## MATERIAL AND METHODS

Both the normal and parasitized hosts commonly occur on the bark of *Acacia arabica*, *Enterolobium saman*, and *Peltophorum* sp., and quite a number of them were also found inside the hollow dry twigs of *Thevetia neriiifolia*. It is of interest, however, that those found in the crevices of the steam of *Borassus flabellifer* in the same locality were unparasitized. The insects were removed from their webs into glass tubes of 4" x 1" capacity open at both ends and plugged with cotton. A number of parasitized host larvae of *Oligotoma minuscula* and *Parembia* sp. were kept in separate tubes with bits of bark. Present observations show that only a small percentage of the hosts were

TABLE I

Hymenopterous parasite	Distribution	Embiopteran host	Authority
<b>Family : Sclerogibbidae</b>			
1. <i>Probethylus callani</i> Richards	Trinidad (W. Indies)	<i>Pararhagadochir trinitalis trinitalis</i> (Saussure)	Richards (1939) Callan (1952)
2. <i>Sclerogibba embiidarum</i> (Kieff.)	India, Ceylon.	i. <i>Oligotoma greeniana</i> Enderlein ii. <i>O. minuscula</i> End.	Richards (1939) Richards (1958)
3. <i>Probethylus</i> (= <i>Sclerogibba</i> ) <i>embiopterae</i> (Dodd)	Queensland (Australia)	<i>Oligotoma gurneyi gurneyi</i> Frogg	Dodd (1939) Callan (1952)
4. <i>Sclerogibba longiceps</i> Richards	Madras (S. India)	<i>Parembia</i> sp.	Richards (1958)
5. <i>Sclerogibba</i> sp.	Madras (S. India)	<i>Pseudembia flava</i> Ross	Richards (1958)
<b>Family : Scelionidae</b>			
6. <i>Embidobia australica</i> Dodd	N. S. Wales (Australia)	i. <i>Metoligotoma ingens</i> Davis ii. <i>M. illawarae illawarae</i> Davis	Dodd (1939)
7. <i>E. metoligotomae</i> Dodd	Australia	i. <i>M. ingens</i> Davis ii. <i>M. intermedia</i> Davis iii. <i>M. extoris</i> Davis iv. <i>M. pentanesiana</i> Davis v. <i>M. tasmanica</i> Davis	Dodd (1939)
8. <i>E. urichi</i> Ashmead	Trinidad (W. Indies)	<i>Pararhagadochir trinitalis trinitalis</i> (Saussure)	Ashmead (1895)
9. <i>E. longipennis</i> Dodd	Tasmania	i. <i>Oligotoma gurneyi gurneyi</i> Frogg ii. <i>Notoligotoma nitens</i> Davis	Dodd (1939)
10. <i>E. orientalis</i> Dodd	Ceylon	<i>Oligotoma greeniana</i> Enderlein	Dodd (1939)

normally parasitized in nature. Unparasitized host larvae were also reared in large test tubes for purposes of parasitization in captivity. On emergence, the adult males and females of *Sclerogibba longiceps* and *S. embiidarum* were paired in labelled test tubes to study their reproductive habits. After copulation, each fertilized female was introduced into a test tube containing the host larvae, in order to observe the mode of attack on the host, the ovipositing habits, and

the reproductive capacity of the parasites. The parasitized larvae were then separated and kept individually to study the duration of the immature stages of the parasites.

#### IMMATURE STAGES

**EGG:** The eggs of *S. longiceps* as well as those of *S. embiidarum* are typically hymenopteriform; the chorion is quite smooth and coloured dull-white; a considerable portion of the egg is embedded into the intersegmental membrane of the host and hence scarcely visible soon after it is laid. However, after three or four days, the eggs are quite clearly visible to the naked eye. The eggs of *S. longiceps* measure, on an average, 0.448 mm. long and 0.242 mm. wide, while those of *S. embiidarum* are slightly longer (0.500 mm. long and 0.254 mm. broad). The incubation period lasts from four to eight days in *S. longiceps* and from six to ten days in *S. embiidarum*.

A remarkable uniformity seems to exist among the species, like most Bethyids to which they are closely related, regarding the position and number of eggs laid on their respective hosts. Thus, *S. longiceps* lays the eggs always in the intersegmental regions of the abdomen towards the left or right side, slightly dorsal and longitudinal in position as in *Parasierola gallicola* (Bethyidae) (Silvestri, 1923*b*) with the posterior end directed caudad. A maximum of five and a minimum of two and, in the majority of instances, three eggs are deposited on a single host. *S. embiidarum*, on the other hand, lays a single egg whose position is invariably restricted to the cervical and the thoracic regions. The egg occupies the intersegmental groove between the neck and the protergum or between the successive segments of the thorax. A similar instance is pointed out by Dodd (1939) in *Oligotoma gurneyi gurneyi* Frogg., forming the host of *Probethylus* (= *Sclerogibba*) *embioptræ*, wherein the single egg of the parasite is attached between the prothorax and mesothorax dorsally of the Embiid larva. Similarly, Callan (1939) notes that the egg of the hymenopteran parasite *Probethylus callani* Richards 'invariably occupied a transverse position on the dorsal surface of the thorax of the host, being attached usually between the head and prothorax or between the pro- and meso-thoracic segments'.

**FIRST STAGE OF LARVA:** The newly hatched larva cannot be easily distinguished from the egg since there is no marked change in colour or shape and also due to the fact that it never changes its position for feeding on the host but uses the oviposition puncture itself for the sucking of host fluids (Plate, fig. c). However, a closer observation reveals slow movements of the body at the hind end

which indicate the presence of the larva. The segmentation of the body is not well marked. The body is coloured pale white and there is a pair of distinct mandibles. After twelve hours a moult takes place and the colour changes into light yellow. The duration of the first instar is quite short in both the species of *Sclerogibbids*.

**SECOND STAGE OF LARVA:** The body grows in size and becomes distinctly curved; colour turns to light yellow. The body reveals thirteen segments besides the head which has strong mandibles. The larva is provided with three long bristles on the dorsal side of each segment and two or one per segment ventrally. Body measures 0.742 mm. and 2.00 mm. in length in *S. longiceps* (Plate, fig. *d*) and *S. embiidarum* respectively. The larvae retain the moulted skin or exuviae in the same manner as described by Hyslop (1916) for *Pristocera armifera* (Bethyilidae), but with this difference that the exuviae stick on to the anterior dorsal region of the body.

**MATURE LARVA:** The larva grows remarkably in size by eating the host body voraciously. The colour becomes brown or dirty-black. The larva often stands erect with the caudal end turned upwards in *S. longiceps* while in *S. embiidarum* it retains its horizontal position on the host. The mature larva is arched in the middle so as to be spindle-shaped. The head bears a few bristles and each thoracic segment has a long bristle dorsally. The abdominal bristles are short or absent. The length of the mature larva largely depends on the amount of food it has derived from the host. In *S. longiceps* (Plate, fig. *e*) where the number of larvae feeding on one host varies from two to five, there exists remarkable variations regarding the size, varying from 1.00 mm. to 1.80 mm. in length. The mature larva of *S. embiidarum* grows normally to a length of 2.7 mm. to 3.0 mm.

The entire host is consumed leaving no remnants whatsoever, and the duration of the feeding phase is remarkably short varying from 24 to 48 hours in *S. longiceps* and 24 to 72 hours in *S. embiidarum*. After consuming the host, the larvae move apart from each other before passing into the pupal stage. Locomotion is very slow and the distance traversed never exceeds a few centimetres.

**PUPAL STAGE:** After about an hour of rest, the larva spins a cocoon which is cylindrical and oblong, measuring 1.80 mm. to 2.0 mm. in *S. longiceps*, 2.3 mm. in *Sclerogibba* sp. (bred on *Pseudembia flava*), and 3.20 mm. to 4.0 mm. in *S. embiidarum*, in length. In *S. longiceps* (Plate, fig. *f*), when the parasites exceed the number two per host, there occurs gradation in the size of the cocoons. In one

TABLE II  
Table showing the measurements at different stages of *S. longiceps* and *S. embiidarum*

	Egg		First stage larva, length in mm.	Second stage larva, length in mm.	Mature larva, length in mm.	Pupa, length in mm.	Length of adult in mm.	
	Length in mm.	Width in mm.					Male	Female
<i>S. longiceps</i> ..	0.448	0.242	0.532	0.742	1.792	1.90	1.9—2.1	1.7—1.85
<i>S. embiidarum</i> .	0.500	0.254	1.00	2.00	2.99	3.40	2.9—3.5	2.6—3.1

instance, it was observed that out of the five larvae bred on a third instar larva of *Parembia* sp., two constructed cocoons of average size, two others smaller cocoons and the remaining one a very flimsy one. One end of the cocoon bears a black spot and it is by cutting through this end that the adult parasite emerges. The cocoons of the Sclerogibbids are never matted together but are always solitary. Often, they become inconspicuous when the faecal matter of the parasite adheres on the surface.

Soon after its formation the pupa is coloured white, but as development proceeds the colour turns first to light brown and eventually differentiation of the adult coloration takes place. The general shape of the pupa is similar to that of the bethylids, the only difference being in the size. The pupa of *S. longiceps* measures 1.90 mm. and that of *S. embiidarum* 3.40 mm. in length. The duration of the pupal period is rather prolonged and varies from 14 to 18 days and on an average 16 days in *S. longiceps*, and from 12 to 16 days in *S. embiidarum*. The parasite remains inside the cocoon for 1 to 3 days even after attaining maturity, probably waiting for the exoskeleton to become well hardened. All the eggs deposited on a host develop into adults at about the same time, the difference, noted in a few instances, never exceeding 12 hours.

TABLE III  
showing the duration of immature stages of :  
1. *S. longiceps* Richards

No.	Date of parasitization	Egg stage in days	Larval stage in hours	Pupal stage in days	Date of adult emergence	Total number of days
1	2-2-'57	4	24	18	25-2-'57	23
2	2-2-'57	4	24	18	25-2-'57	23
3	4-2-'57	5	24	16	26-2-'57	22
4	5-2-'57	8	36	16	2-3-'57	25½
5	5-2-'57	8	24	16	2-3-'57	25
6	12-2-'57	5	24	14	4-3-'57	20
7	20-2-'57	7	48	16	17-3-'57	25
8	28-2-'57	6	36	15	22-3-'57	22½
9	30-3-'57	7	48	14	22-4-'57	23
10	11-4-'57	8	48	16	7-5-'57	26

2. *S. embiidarum* (Kieff.)

No.	Date of parasitization	Egg stage in days	Larval stage in hours	Pupal stage in days	Date of adult emergence	Total number of days
1	24-3-'57	7	60	16	19-4-'57	25½
2	25-5-'57	6	48	13	15-4-'57	21
3	25-3-'57	6	48	13	15-4-'57	21
4	27-3-'57	8	48	12	18-4-'57	22
5	28-3-'57	9	48	14	22-4-'57	25
6	28-3-'57	9	48	14	22-4-'57	25
7	2-4-'57	10	72	13	28-4-'57	26
8	3-4-'57	10	48	15	30-4-'57	27
9	3-4-'57	10	48	16	1-5-'57	28
10	3-4-'57	9	24	15	28-4-'57	25

From Table III it is clear that the duration of the life-cycle is quite short, ranging from 20 to 26 days in *S. longiceps* and 21 to 28 days in *S. embiidarum*. It is also evident that the period devoted to actual feeding is quite short while the pupal stage is a prolonged one.

## ADULT PARASITE

The females of both *S. longiceps* and *S. embiidarum* are apterous while the males are fully winged and are good fliers. The parasites are antilike and very active, moving about with extreme briskness. The males are slightly longer in both species. The males are uniformly black in *S. embiidarum* while the females are bicolorous, with the thorax brown and the abdomen black.

## FEEDING HABITS

It is most common among Bethyids to derive their food from their respective hosts either by merely sucking the body juices leaving the hosts alive or by killing them. The Sclerogibbids, though closely related to the Bethyids, are of interest since they were not at all observed to attack the host larvae for feeding purposes. However, the parasites can be fed and kept alive under captivity with a weak solution of sugar.

## HOST PREFERENCE AND MODE OF ATTACK ON THE HOST

The larvae parasitized by *S. longiceps* all belong to the subgenus *Parembia* Davis of an undetermined species which is of very common occurrence in Madras. Among the larvae, the third and fourth instars were the victims of parasitization while the other stages of larvae were not attacked. Similarly, all the specimens of *S. embiidarum* were bred on the fifth instar larvae of *Oligotoma minuscula*, which is also found in large numbers in Madras during almost all seasons of the year. However, it is of special interest to observe that the host preference of *S. embiidarum* is not very specific, for Richards (1939) has recorded this parasite from Ceylon, Madras and Mangalore, parasitizing *Oligotoma greeniana* Enderlein. This lack of host specificity seems to be quite common among the Scelionidae attacking the eggs of Embioptera, and Dodd (1939) records as many as five species of hosts for *Embidobia metoligotomae* Dodd from Australia. It is also noteworthy that one and the same species of Embioptera may be parasitized for the purpose of oviposition by two different species of parasites—one attacking the eggs while the other attacks the larvae. For instance, the larvae of *Oligotoma greeniana*, as has been pointed out, are parasitized by *Sclerogibba embiidarum* while the eggs of this Oligotomid are attacked by the Scelionid parasite *Embidobia orientalis*.

In the experiments conducted in the course of the present study, females of *Sclerogibba longiceps* were offered, besides *Parembia* sp., larvae of other embiids such as *Pseudembia flava*, *O. falcis*, *O. saundersii*, *O. humbertiana*, and *O. minuscula*, all of which are found in plenty in the same locality in Madras. It was observed that the parasite did not attack any host other than *Parembia* sp., thus showing remarkable host specificity. *S. embiidarum*, on the contrary, was noticed to lay eggs on the larvae of *Oligotoma falcis* and *Parembia* sp., when not provided with its natural host, namely *O. minuscula*; but, the position of the eggs was on the abdominal segments though the number of eggs per host was only one. However, the preference for *O. minuscula* is evident from the fact that in the field no larvae other than those of *O. minuscula* were observed to be parasitized by *S. embiidarum*. The significance of selecting *O. minuscula* by *S. embiidarum* may be that the host completes its life-cycle within the comparatively short time of 2½ to 3 months while the other species of Oligotomids require 4 or 5 months and *Parembia* sp. 7 or 8 months. Since the life-span of the parasite ranges from 30 to 40 days only, it would naturally be more difficult for the parasite to have access to the proper host larva if

the duration of life-cycle of the latter is a prolonged one and consequently only one or two generations per year. *O. minuscula* appears to have enough number of generations every year and there is no scarcity of the host at the specific larval stage during all seasons; all these factors account for the host preference of *S. embiidarum* for *O. minuscula*. In the case of *S. longiceps*, correlated with the prolonged life-cycle of the host, the parasites are not frequently met with during the major part of the year.

The mode of attack on the host by Sclerogibbids is distinctive. The host is usually confined inside its web and attacks on exposed hosts seldom occur. As described by Clausen (1940) this also appears to be the case in most Bethylids. Male parasites have not been observed to attack the host while the females do so only for oviposition. The parasite crawls over the webs and, on scenting the presence of the proper host, cuts the webs with its powerful mandibles, enters it, and attacks the host from behind by biting at various regions, an act which apparently makes the host stop its movements the antennae alone vibrating slowly. It is of interest to mention that the mode of attack on the host by *Laelius anthrenivorus tranii* (Bethylidae) described by Howard (1901) is essentially the same as the one noted in the present study. The host remains partially paralysed for a short time extending from 30 minutes to an hour during which time the parasite inserts her ovipositor through the intersegmental membrane of the host and lays her eggs, anchoring them deeply with one-third of the egg embedded inside the host body. The host invariably regains consciousness and assumes its normal activities; however, the parasitized larvae become more and more sluggish as the parasite eggs hatch into larvae. The parasitized larvae of *Parembia* sp. become pale yellow in colour and locomotion is rendered extremely difficult due to the weight exerted by the growing parasites numbering from two to five, and due to the loss of body fluids sucked continuously by them. The parasitized larva of *O. minuscula*, on the other hand, is quite as active as any other unparasitized ones until the parasitic larva completes the second instar stage, because the number of parasites per host is only one and its position is on the thorax. But, ultimately, with further feeding and development of the parasite, the host loses its power of locomotion.

#### LONGEVITY AND FECUNDITY

The males of both the species of Sclerogibbids studied live for 2 to 4 days only during which time copulation takes place. The females, on the contrary, thrive for a comparatively longer time.

In captivity and with food supply, females of *S. longiceps* were observed to live for about 15 days, and without food they lived only for 2 to 5 days. Females of *S. embiidarum* could be kept alive for 10 to 21 days with food supplies. Copulation took place only once soon after the parasites emerged from the cocoons and the preoviposition period ranged from 2 to 4 days. The maximum total number of eggs laid by a single female of *S. longiceps* in captivity was only 18 deposited on 6 host larvae, while the minimum was 7 distributed on 2 larvae. The reproductive capacity of *S. embiidarum* was found to be still lower, the maximum and the minimum being 9 and 5 respectively. Thus the reproductive capacity of these parasites is exceptionally low unlike most Bethyids.

#### SEX-RATIO AND PARTHENOGENESIS

All the eggs deposited on a host develop into the same sex, either male or female. In studying the sex-ratio, the larvae parasitized by individual females were isolated and the total number of males and females developing from them were taken into account. As in most parasitic Hymenoptera, the females always preponderate in both the species of *Sclerogibbids* studied, giving a sex-ratio of 2:5 in *S. longiceps* and 2:3 in *S. embiidarum*.

TABLE IV  
showing the sex-ratio of *S. longiceps* and *S. embiidarum*

	<i>S. longiceps</i>				<i>S. embiidarum</i>			
	I	II	III	IV	I	II	III	IV
Total number of individuals emerged ...	18	9	10	7	9	5	8	5
Number of males ..	5	3	3	2	4	2	3	2
Number of females ..	13	6	7	5	5	3	5	3
Sex-ratio of male : female	2 : 5				2 : 3			

Parthenogenesis has been observed in *Sclerogibba embiidarum*, all the resulting progeny being females.

## EXTENT OF EFFICIENCY IN BIOLOGICAL CONTROL

Among many other factors, the efficiency of biological control depends largely on the opportunities of gaining access to the proper host to ensure the production of enough number of offspring and their further multiplication. Both the species of *Sclerogibba* dealt with here, no doubt, have short life-cycles, and consequently a faster reproductive rate. But, the control of the host can be achieved only if the host is attacked at a specific larval stage. This condition, however, is not possible in *S. longiceps* since its hosts, *Parembia* sp., as already stated, have a long larval duration and but a single generation per year. It is due to this reason that *S. longiceps* is not of frequent occurrence during the major part of the year. They are to be found in Madras only from the months of January to April during which period the host is in its third or fourth larval stages and most susceptible. Attempts to collect them during the months May to December met with failure. Regarding *S. embiidarum*, its host *O. minuscula* is found in Madras practically throughout the year in the larval as well as in adult stages and this accounts for the availability of the parasite at any time, though during some months of the year their occurrence is maximum as is revealed from a study of the population count of this species in Madras in an area of approximately 5000 sq. yards with thickly crowded trees. The population count was taken for a period of 12 months—February 1957 to January 1958. Parasitized larvae of *O. minuscula* were collected regularly once each week during all months and the parasites were reared to maturity. It was found that there was a regular increase in the number of the parasites from January to April attended by a regular rise in the temperature, culminating in May when the temperature was 30.80° C. A subsequent decrease took place from June onwards till October, and in the month of November not a single parasitized specimen was noticeable. It, therefore, appears that the absence of rainfall and a fairly high temperature are conditions most favourable for the rapid multiplication of the parasites while heavy showers are inimical to them (Table V). Thus, the occurrence of the parasites throughout the year is a factor favourable in the control of the host. However, the habit of the parasite to lay only a single egg per host is no doubt a handicap.

The other factors which limit the efficiency of both the species of *Sclerogibba* under consideration are the low reproductive capacity, the very short life-span of the adults, and their susceptibility to extremes of climatic conditions.

TABLE V

showing the seasonal variation in the availability of  
*S. embiidarum*

Month	No. of parasites	Maximum temperature in ° C.	Minimum temperature in ° C.	Mean temperature in ° C.	Total rain- fall in inches
February 1957 ..	21	29.5	20.6	25.0	0.20
March ..	26	30.5	22.5	26.5	nil
April ..	30	32.4	25.1	28.8	nil
May ..	34	34.1	27.4	30.8	0.40
June ..	14	36.1	27.1	31.6	1.39
July ..	14	34.4	25.8	30.1	5.59
August ..	8	32.9	25.1	29.0	5.58
September ..	4	33.9	25.3	29.6	3.59
October ..	4	31.4	24.3	29.9	8.59
November ..	nil	28.9	23.3	26.1	16.63
December ..	14	28.5	22.0	25.3	0.11
January 1958 ..	18	29.0	20.5	24.8	0.39

## SUMMARY

The host relations of the Sclerogibbids, as far as is known from five species, reveal that they are restricted to Embioptera. While the Sclerogibbids parasitize the larvae of Embioptera, the Scelionids attack the eggs of the Embiids. The life-history and habits of two species of Sclerogibbids, namely *Sclerogibba longiceps* and *S. embiidarum* are described. The larval features in both the species are similar, while important differences could be noticed regarding the number of eggs laid on their respective hosts, their position on the host body, and the time taken in consuming the entire host. Both the species have short life-span and the feeding phase is remarkably short. The parasites exhibit host specificity to a considerable degree. The host is paralysed only temporarily for oviposition, and attack on the host for feeding purposes is not met with. The reproductive capacity of the parasites seems to be low which circumscribes to a large extent their efficiency in the control of the host. In sex-ratio, the females preponderate. Correlated with the long life-cycle of its host, *S. longiceps* is not found for the major part of the

year, while *S. embiidarum* is of common occurrence during almost all months. Field population studies of *S. embiidarum* reveal that they increase in number with the rise of temperature and in the absence of rainfall.

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